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Case Study: Monitoring of AIR quality in King Faisal University using a microcontroller and WSN

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Abstract

Wireless sensor network (WSN) enhanced the process of monitoring many environmental phenomena such as the air pollution monitoring issue in proposed this paper. In this paper, a WSN based microcontroller equipped with gas sensors have been actively used for air quality monitoring. The design included several units mainly: Arduino Microcontroller, MQ-2 Gas Sensors, and the current regulator circuit. Based on the normal gas levels of the clean air, the obtained results indicate that there is a big difference in the gas levels of both gases (LPG and CO) which obtained from the several tests and circuit runs. However, the acquired results for the air quality control inside the KFU buildings show no risky situation to be considered for further actions. This work will apply the electrical engineering techniques as well as environmental engineering knowledge by using wireless sensor networks to measure Air Quality Parameters such as Carbon Monoxide (CO) and Liquid Petroleum Gas (LPG).

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Keywords: Wireless sensor network, Arduino Microcontroller; Air Pollution; Air Quality; MQ-2 Gas Sensors.

1. Introduction

The technology of Wireless Sensor Networks (WSNs) [4] is in the front part of the investigation of the computer networks and it could be the next technologic market of a huge sum of money. Sensor nodes have limited processing power, storage, bandwidth, and energy. This limitation makes provision of the security in sensor networks not an easy task [4]. The availability of cheap, low power, and miniature embedded processors, radios, sensors, and actuators, often integrated on a single chip, is leading to the use of wireless communications and computing for interacting with the physical world in applications such as air quality control.

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Sensor networks may consist of many different types of sensors [5] such as seismic, low sampling rate magnetic, thermal, visual, infrared, acoustic and radar, which are able to monitor a wide variety of ambient conditions [5] such that: temperature, humidity, air quality, vehicular movement, lightning condition, pressure, soil makeup, noise levels, the presence or absence of certain kinds of objects, mechanical stress levels on attached objects, and the current characteristics such as speed, direction, and size of an object. A sensor node is made up of four basic components [5] as shown in Figure 1: a sensing unit, a processing unit, a transceiver unit and a power unit.

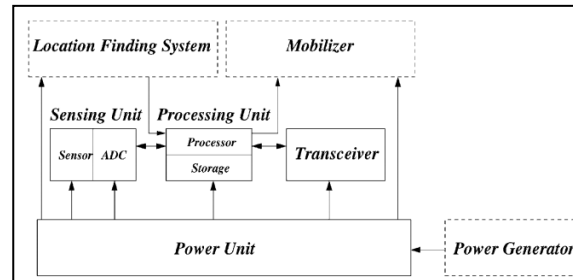


Figure 1: The Hardware Design Schematic Diagram.

In this paper, we propose to use a WSN based microcontroller equipped with gas sensors have been actively used for air quality monitoring. The design included several units mainly: Arduino Microcontroller, MQ-2 Gas Sensors, and the current regulator circuit.

2. Proposed Air Monitoring System Design

The complete system design is shown in figure 2, Hardware Design Schematic Diagram. The design Included the following major hardware components:

1. Arduino Microcontroller [1]: this is the core component of the design. Arduino is a flexible programmable hardware platform designed for artists, designers, tinkerers, and the makers of things. Arduino's little, blue circuit board, mythically taking its name from a local pub in Italy, has in a very short time motivated a new generation of DIYers of all ages to make all manner of wild projects found anywhere from the hallowed grounds of our universities to the scorching desert sands of a particularly infamous yearly arts festival and just about everywhere in between. Usually these Arduino-based projects require little to no programming skills or knowledge of electronics theory, and more often than not, this handiness is simply picked up along the way.
2. MQ-2 GAS Sensor [3] Breakout Board: MQ-2 is one of the series of semiconductor Gas Sensors that is used mainly for gas (such as CO) leak detection for houses, workshops, commercial building, Fire, Safety detection system as well as a gas leak alarm. MQ-2 has many features such as: High sensitivity, Fast response, Wide detection range, Stable performance and long life, Simple drive circuit.
3. Resistance Circuitry: Resistance value of MQ-2 is difference to various kinds and various concentration gases. So, When using this components, sensitivity adjustment is very necessary. we recommend that you calibrate the detector for 1000 ppm liquified petroleum gas <LPG>, or 1000 ppm iso-butane<i-C₄H₁₀>concentration in air and use value of Load resistance that(RL) about 20 K Ω (5K Ω to 47 K Ω).
4. Current Regulator Circuit: this electric circuit is needed to regulate the amount of current used to heat and operate the MQ-2 sensor as well as to adjust the sensitivity of the sensor for better calibration readings.

5. ADC (analog-to-digital converter): is a device that converts a continuous quantity to a discrete digital number. Typically, an ADC is an electronic device that converts an input analog voltage (or current) to a digital number proportional to the magnitude of the voltage or current. This functionality has been performed by Arduino Microcontroller.
6. Light Emitting Diodes: two LEDs used as indicators.
7. Plastic Cabinet: to hold the connected components of the design as one package.

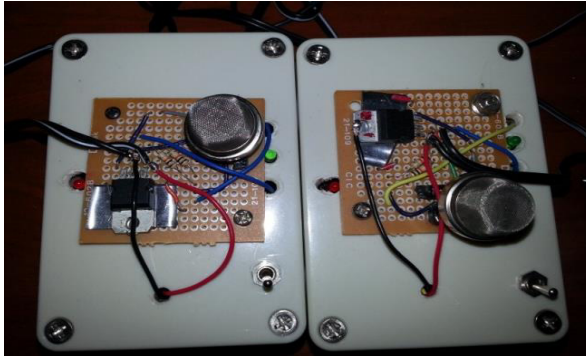


Figure 2: The Hardware Design Schematic Diagram.

3. Results And Discussion

The proposed design were used to measure the air quality in several places inside the King Faisal University and included different gases levels but focused mainly on measuring tow main gases: Carbone Monoxide (CO) and Liquid Petroleum Gas (LPG). A sample of obtained results from both clean environment and KFU library are shown in table 1, figure 3 and figure 4.

Table 1. Clean Air Vs. KFU Library

Clean Air		KFU Library	
LPG	CO	LPG	CO
2.06	0.03	80.77	1.63
4.41	0.02	85.92	1.87
3.49	0.02	76.59	2.73
2.56	0.04	54.54	4.45
2.21	0.05	49.81	0.68
2.03	0.03	52.55	3.65
2.12	0.02	78.1	0.98
2.12	0.03	68.21	5.94
3.4	0.02	61.71	5.03
4.51	0.02	46.51	1.45
2.21	0.06	96.09	6.04
3.13	0.02	75.38	5.92
2.63	0.03	102.3	4.13

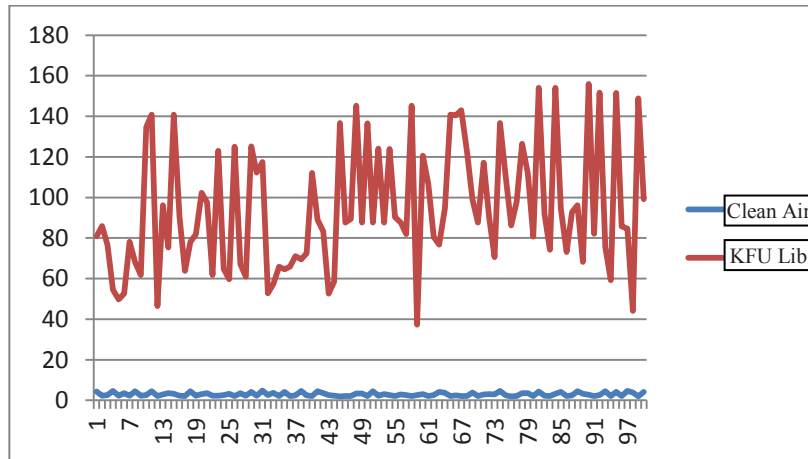


Figure 3: Concentration of Liquid Petroleum Gas Levels in Clean Air and KFU Library.

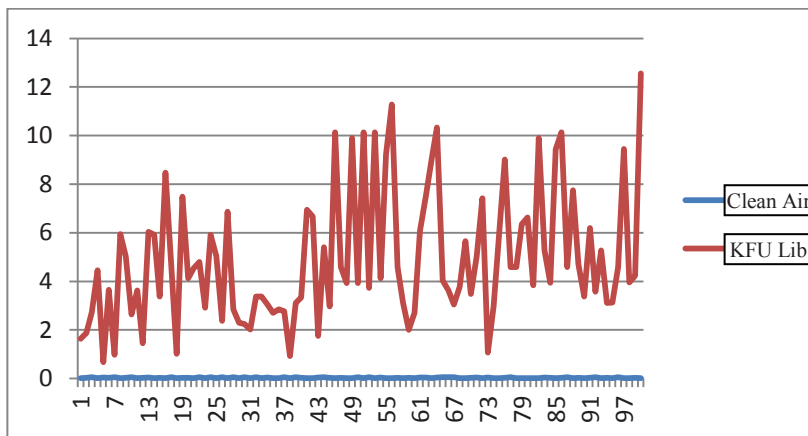


Figure 4: Concentration of Carbon Monoxide Levels in Clean Air and KFU Library.

Based on the normal gas levels of the clean air [2], the results indicate that there is a big difference in the gas levels of both gases (LPG and CO) which obtained from the several tests and circuit runs. However, the acquired results show no risky situation to be considered for further actions.

4. Conclusions And Recommendations

AIR Quality Control System Design to monitor the pollution of air in King Faisal University using a microcontroller and Wireless Sensor Network (WSN) is proposed in this article. WSN enhanced the process of monitoring many environmental phenomena such as the air pollution monitoring issue in proposed this paper. It provides a real-time information about the level of air pollution in different regions, as well as provide alerts in cases of drastic change in quality of air. Based on these readings, such information can then be used by the authorities to take prompt actions such as evacuating people or sending emergency response team. the design can be enhanced by several ways such as: adding a wireless network card to the microcontroller circuitry for better and easier control of the sensors readings

as well as more sophisticated sensors could be used such as MQ-135, MQ-136 and others. Moreover, the circuit can be improved to measure the level of other gases in the air such Sulfured Hydrogen (H₂S), Ammonia (NH₃), Alcohol and many others.

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